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The Medusa effect reveals levels of mind perception in pictures

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Throughout our species history, humans have created pictures. The resulting picture record reveals an overwhelming preference for depicting things with minds. This preference suggests that pictures capture something of the mind that is significant to us, albeit at reduced potency. Here, we show that abstraction dims the perceived mind, even within the same picture. In a series of experiments, people were perceived as more real, and higher in both Agency (ability to do) and Experience (ability to feel), when they were presented as pictures than when they were presented as pictures of pictures. This pattern persisted across different tasks and even when comparators were matched for identity and image size. Viewers spontaneously discriminated between different levels of abstraction during eye tracking and were less willing to share money with a more abstracted person in a dictator game. Given that mind perception underpins moral judgement, our findings suggest that depicted persons will receive greater or lesser ethical consideration, depending on the level of abstraction.

mind perception | prosociality | moral judgement | eye tracking | dictator game

Human history is awash with pictures. By 40,000 y ago, cave painting was already established (1). Today, humanity uploads billions of photos per day (2). This extraordinary temporal reach is matched by extraordinary geographical reach. Pictures abound on all continents and are produced by virtually all cultures (3, 4). Across this staggering abundance of images, a clear preference in subject matter emerges: things with minds. Cave paintings around the world depict humans, animals, and their interactions (1). Social media services host more images of people than of any other image category (5, 6). This preoccupation with minded subjects suggests that pictures capture something of the mind that is significant to us.

In pictorial representations, some features of the depicted reality are lost, and others are preserved. For example, a photo of a tiger loses the scale and motion of the tiger but may preserve its spatial layout and coloration. In this study, we focus on one critical feature of reality that pictures preserve—the capacity to contain pictures. In the same way that reality contains pictures, pictures too may contain pictures. This feature is intriguing, as it introduces a recursive structure in which different levels of abstraction may be nested.

Some terminology will be useful in distinguishing these levels of abstraction. We refer to the real world as Level 0 (L0 for short). Most of our visual experiences—including the people and objects in our surroundings—are L0. Pictures within this environment are designated as Level 1 (L1). Cave paintings, family photos, and television images are all examples of L1. Pictures within such pictures are Level 2 (L2). The program for your local art gallery is packed with L2 pictures. Fig. 1 summarizes this scheme.

The sheer prevalence of minded beings in pictures raises the question of how mind perception and pictorial abstraction interact. Some mental attributes do not survive projection into pictures. We do not expect portraits to strike up a conversation. Nevertheless, some embers of mind perception can be detected. For example, pictures of eyes can direct our attention (7); "being watched" by photographic eyes can enhance prosocial behavior (8). Such findings betray perception of a mind behind the depicted eyes. One possible interpretation is that pictures carry the same signal as reality but at reduced strength.

To summarize, on the one hand, pictures allow recursive representation. A picture may contain another picture at a higher level of abstraction. On the other hand, increasing the level of abstraction may decrease the potency of the subject. A picture in the environment just does not have the same force as the environment itself. Combining these two observations suggests a novel hypothesis: L2 pictures should be less potent than L1 pictures. For pictures of people, this raises the prospect of graded mind perception for different levels of abstraction. The purpose of the current experiments is to test this possibility.

Comparing degrees of mind perception requires a quantitative framework. There have been various proposals as to how mind perception can be quantified, including its dimensionality (9–11). Perhaps the most influential of these is the two-dimensional framework proposed by Gray, Gray, and Wegner (9). This framework emerged from a principal component analysis of mind perception data from a large-scale survey. The analysis identified a primary factor of *Experience* (ability to feel), pertaining to moral patiency and rights, and a secondary factor of *Agency* (ability to do), pertaining to moral agency and responsibility. Adopting this framework, we predicted that attributions of Experience and Agency should distinguish L1 and L2 depictions of people. If successive abstractions temper the perceived mind, observers should attribute lower Experience and Agency to people in L2 pictures compared with people in L1 pictures. In short, we predict that mind perception

Significance

Differential treatment of animate and inanimate objects often hinges on mind perception—the attribution of mental states to others. It has already been established that pictures of animate objects can elicit mind perception, albeit at reduced intensity. However, this loss of intensity is assumed to reflect an impoverishment of a rich stimulus, such as the projection of a living being into a static picture plane. The current study overturns this assumption by showing that "pure" abstraction can reduce mind perception independent of stimulus richness. Depicting things with minds raises ethical questions that have not been recognized previously. As these questions emerge from representational structure rather than representational content, they are unlikely to be quashed by improvements in image quality.

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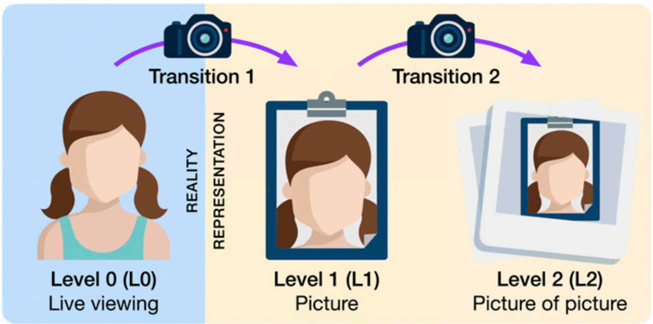

Fig. 1. Levels of pictorial abstraction and transitions between them. The blue background indicates reality (L0), and the yellow background indicates pictorial representation (L1 and L2). L0 (*Left*) refers to the visual environment as seen in live viewing. L1 (*Center*) refers to a picture of the visual environment as seen in photographs. L2 (*Right*) refers to a picture of a picture as when one photograph contains another. Transition 1 ascends one level of abstraction, from L0 to L1. Transition 2 also ascends one level of abstraction, from L1 to L2. Critically, Transition 1 bridges reality and pictorial representation, whereas Transition 2 occurs within the domain of pictorial representation.

will differ between pictures and pictures of pictures, even though both are pictorial representations.

Experiment 1

The purpose of Experiment 1 was to compare the perception of minds in L1 and L2 pictures using a two-alternative forced choice (2AFC) task. To this end, we presented participants with a series of onscreen photos. Each photo contained two people—one in L1 and the other in L2 (Fig. 2*A*).

For each picture, the participants' task was to indicate which person 1) seemed more real, 2) seemed higher in Experience, or 3) seemed higher in Agency. The *Realness* comparison allowed us to test whether mind perception is related to how real the person seems (11). We reasoned that if mind perception recedes with increasing abstraction, participants should perceive L1 as higher than L2 in terms of Experience, Agency, and Realness.

Results and Discussion. Participant responses are summarized in Table 1. One-sample Student's t tests confirmed that the proportion of participants choosing L1 over L2 was significantly above the chance level of 50% for Realness [$t(28) = 17.99$, $P < 0.0001$, $d = 3.34$], Experience [$t(28) = 9.10$, $P < 0.0001$, $d = 1.69$], and Agency [$t(28) = 5.70$, $P < 0.0001$, $d = 1.06$]. That is, on all three dimensions, minds were perceived more keenly in L1 than in L2.

Viewers consistently perceived people in L1 as more real than people in L2. They also attributed more Experience and Agency to people in L1 than people in L2. These findings are consistent with an abstraction cost in mind perception, whereby an additional layer of abstraction blunts the portrayed mind. Cohen's (12) "rules of thumb" for interpreting effect sizes suggests a d value of 0.2 as a small effect, 0.5 as a medium effect, and 0.8 as a large effect. Following these guidelines, the level of abstraction had a large statistical effect ($d > 1$) on all three dimensions. Our next experiment examined the magnitude of this abstraction cost using a different behavioral measure.

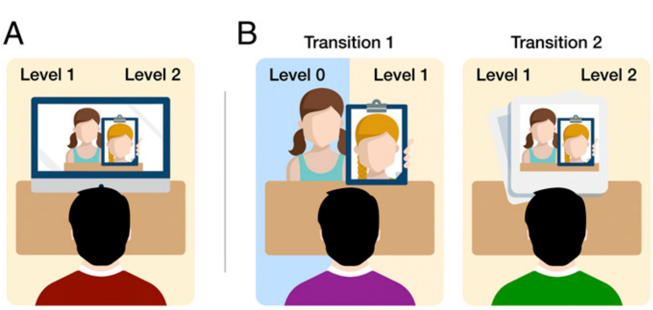

Fig. 2. Schematic of viewing conditions. (*A*) Experiments 1 through 3 and 5. Participants viewed faces at two levels of abstraction (L1 and L2) within the same stimulus display. (*B*) Experiment 4. Half of the participants compared L0 to L1 (*Left*), and half compared L1 to L2 (*Right*). The blue background indicates reality. The yellow background indicates pictorial representation.

Table 1. Summary results of Experiment 1

Dimension	L1	L2
Realness	84	16
Agency	69	31
Experience	70	30

Columns show the levels of abstraction compared by participants. Rows show the three dimensions of comparison. Cells show the mean percentage of participants who chose L1 and L2 for each dimension.

Experiment 2

In Experiment 2, we sought to measure the magnitude of the observed abstraction cost by asking participants to rate each of the two depicted people in each display for perceived Realness, Agency, or Experience. These responses were given along a numeric rating scale ranging from 0 to 10. This change from forced choice response to separate ratings allowed us to estimate the size of the effect on a common scale and to examine generalization across different tasks.

Results and Discussion. Participant ratings are summarized in Table 2. Paired-sample Student's t tests confirmed that participants rated L1 higher than L2 for Realness [$t(106) = 8.62$, $P < 0.0001$, $d = 0.83$], Experience [$t(108) = 3.55$, $P = 0.001$, $d = 0.34$], and Agency [$t(103) = 3.98$, $P < 0.0001$, $d = 0.39$]. On all three dimensions, minds were perceived more intensely in L1 than in L2, demonstrating generalization beyond a 2AFC task.

Abstraction costs occurred whether viewers were asked to choose between depicted people (Experiment 1) or to rate individual people separately (Experiment 2). In the next experiment, we ask whether differentiation between L1 and L2 requires a task at all or whether it occurs spontaneously during passive viewing.

Experiment 3

The stimuli in Experiment 3 were the same as in Experiments 1 and 2. This time, however, no explicit mind perception task was prescribed. Participants were simply asked to view the photos as they normally would while looking behavior was monitored via an eye tracker. Classic eye-tracking studies have shown that viewers preferentially attend to people in scenes (13, 14). If differentiation between L1 and L2 occurs even during free viewing, then eye tracking should reveal systematic differences in looking behavior. Alternatively, if differentiation between L1 and L2 requires an explicit mind perception task, then no systematic differences should emerge.

Table 2. Summary results for Experiment 2

Dimension	L1	L2
Realness	7.83	5.48
Agency	6.85	6.18
Experience	6.98	6.55

Columns show the levels of abstraction rated by participants. Rows show the dimensions of the three dimensions for rating. Cells show the mean rating that participants gave to L1 and L2 for each dimension.

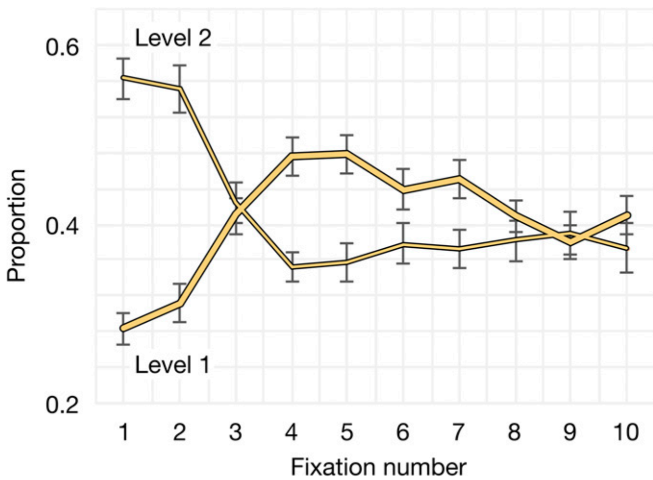

Fig. 3. Eye-tracking data from Experiment 3. Fixations 1 to 10 (starting central fixation excluded), averaged across all participants and stimulus displays. Data points show proportion of fixations to L1 person (thick line) and L2 person (thin line). Error bars show SE.

Results and Discussion. Eye-tracking data are summarized in Fig. 3. Looking behavior distinguished between L1 and L2 rapidly and spontaneously. Fixations initially favored L2, possibly reflecting early scene segmentation. This was followed by a more extended preference for L1, consistent with deeper social processing, after which the distinction between L1 and L2 lapsed.

Repeated-measures ANOVA confirmed that the interaction between level of abstraction and fixation number was statistically significant [$F(5.64,\ 197.53) = 19.45$, $P < 0.001$, $\eta^2 = 0.211$]. Pairwise comparisons revealed significant differences between L1 and L2 at fixations 1, 2, 4, 5, and 7 ($P < 0.05$, Bonferroni corrected; *SI Appendix*). In sum, viewers' distinction between L1 and L2 was evident from the very first eye movement. This observation establishes some important boundary conditions. Differentiation between people at different levels of abstraction occurs spontaneously in the absence of task demands. Its effects emerge within the first moments of exposure and guide subsequent visual exploration.

So far, all of our experiments have presented a range of naturalistic scenes. This approach leaves open the possibility that characteristics of our stimulus set could account for the observed differences. For example, it is possible that L1 and L2 differed systematically in terms of facial appearance, giving rise to systematically different mental attributions (15). Previous work has shown that some faces look more real than others (16). Similarly, Gray, Gray, and Wegner (9) found that some people elicit higher Experience and Agency ratings than others (e.g., people of different ages). A more superficial difference was image size. L1 faces were generally bigger than L2 faces in terms of visual angle. In principle, this size difference could also influence participants' responses. The purpose of Experiment 4 was to replicate the picture abstraction cost while addressing these concerns.

Experiment 4

To equate facial appearance across levels of abstraction, we created new presentations in which the same individuals appeared in L1 and L2. To rule out possible effects of image size, we matched image size across conditions. If the pattern in Experiments 1 to 3 was an artifact of stimulus selection, then it should be eliminated here. If the pattern was due to a change in the level of abstraction, then it should persist, despite the new matched stimuli.

We also took this opportunity to place the magnitude of the picture abstraction cost in context by comparing transitions between different levels of representation (Fig. 2*B*). In Transition 1, we asked viewers to compare a live face (L0) to an L1 picture of a face. Given that people readily distinguish between reality and pictures (17, 18), we expected that viewers would perceive L0 as higher in Realness, Experience, and Agency than L1. Transition 1 thus provides a baseline against which to compare transitions between different levels of pictorial representation. In Transition 2, we asked viewers to compare an L1 picture with an L2 picture as in the preceding experiment. We expected that viewers would again perceive L1 as higher in Realness, Experience, and Agency compared with L2.

Finally, if there is something "special" about the transition from reality to representation, the observed picture costs should be larger for Transition 1 (L0 versus L1) than for Transition 2 (L1 versus L2). Alternatively, if transitions among different levels are equivalent, the picture costs in Transition 1 and Transition 2 should be of similar magnitude.

Results and Discussion. Participant responses are summarized in Table 3.

For Transition 1, binomial tests on each dimension confirmed that the proportion of participants choosing L0 over L1 was significantly above chance (Realness: $z = 7.3$, $P < 0.000001$, Cohen's $g = 0.37$; Agency: $z = 7.5$, $P < 0.000001$, $g = 0.38$; Experience: $z = 6.7$, $P < 0.000001$, $g = 0.34$). For Transition 2, the proportion of participants choosing L1 over L2 was significantly above the chance level of 50% for Realness ($z = 3.9$, $P < 0.0001$, $g = 0.20$) and Agency ($z = 5.1$, $P < 0.000001$, $g = 0.26$) but not for Experience ($z = 1.5$, $P = 0.134$, $g = 0.08$). That is, L2 depictions seemed lesser than L1 depictions in terms of Realness and Agency but retained apparent Experience.

χ^2 tests revealed that, on each dimension, the preference for the lower level was stronger in Transition 1 than in Transition 2 (Realness: $\chi^2 = 7.58$, degrees of freedom [df] = 1, $P = 0.0059$, Cramer's $V = 0.2069$; Experience: $\chi^2 = 15.18$, df = 1, $P < 0.0001$, $V = 0.2865$; Agency: $\chi^2 = 4.1$, df = 1, $P = 0.0429$, $V = 0.1562$). A transition within the picture domain incurred a significant abstraction cost but not as great a cost as a transition from reality to pictures.

It may not be surprising that mind perception differs for pictures versus reality. After all, pictures lack many characteristics of their real-world counterparts, including characteristics that may contribute to mind perception (e.g., movement, sound, three-dimensional presence). What is more surprising is that mind perception differs between pictures and pictures of pictures. This disparity cannot be explained by an appeal to special properties of reality, as the relevant comparison concerns only different regions of the same image. The striking implication is that levels of abstraction can influence mind perception independent of physical substrate. In the final experiment, we examined behavioral consequences of this perceptual effect.

Experiment 5

Economic games have long been used in experimental psychology to examine factors that influence behavior in everyday social interactions (19). In the dictator game (20), the participant controls a sum of money. The participant's task is to decide how

Table 3. Summary results of Experiment 4

	Transition 1		Transition 2	
Dimension	L0	L1	L1	L2
Realness	87	13	70	30
Agency	88	12	76	24
Experience	84	16	58	42

Columns show the levels of abstraction compared by Transition 1 participants and Transition 2 participants. Rows show the three dimensions of comparison. Cells show the percentage of participants arriving at each judgement.

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much of this money to allocate to a recipient. The recipient has no influence over the size of the allocation, and the participant keeps whatever is left.

Part of the appeal of the dictator game is its external validity as a measure of fairness and prosociality. Behavior in the dictator game is associated with prosocial personality traits (21–23), and the size of allocation predicts prosocial behavior in a variety of real-world tasks (24, 25). More importantly for the current study, the size of allocation is also sensitive to the social salience of the recipient (26–28).

By analogy with manipulations of social salience, we hypothesized that pictorial abstraction would reduce dictator game allocations by reducing the perceived mind of the recipient. To test this possibility, we compared monetary allocations to L1 or L2 recipients in an online experiment. To relate behavior to perception, we ran a one-shot dictator game in the context of the mind perception task from Experiment 4. We expected that 1) participants would again perceive L1 as higher than L2 in terms of Realness, Agency, and Experience, 2) participants who were asked to make dictator game allocations to L1 would offer more than participants who were asked to make allocations to L2, and 3) effects in the dictator game would be attributable to effects in the mind perception task.

Results and Discussion.

Perceptual effects. Participant responses are summarized in Table 4.

Binomial tests confirmed that the proportion of participants choosing L1 over L2 was significantly above the chance level of 50% for each dimension (Realness: z = 9.3, $P < 0.000001$, Cohen's $g = 0.33$; Agency: z = 7.7, $P < 0.000001$, $g = 0.28$; Experience: z = 7.4, $P < 0.000001$, $g = 0.27$). Once again, the level of pictorial abstraction influenced mind perception.

Behavioral effects. In the dictator game, participants allocated a share of their $10 endowment to either an L1 or L2 recipient (between groups manipulation). One participant had missing data. Dictator game responses are summarized in Fig. 4.

Dollar allocations were significantly higher for L1 (n = 99, M = $5.48) than for L2 ($n$ = 100, M = $4.42; Mann–Whitney U = 3,928.5, z = 2.51, $P = 0.0121$, Cohen's $d = 0.36$), corresponding to a picture abstraction cost of $1.06. L1 allocations exceeded L2 allocations in all four counterbalanced versions of the experiment, demonstrating generality across recipients and images.

Individual differences in perception and behavior. Analysis of individual differences allowed us to trace these behavioral outcomes to their perceptual antecedents. Participants who perceived L1 as higher than L2 on all three dimensions (Realness, Agency, and Experience; n = 114) differentiated strongly between L1 and L2 in their dictator game allocations (abstraction cost $1.49; Mann–Whitney U N1 = 55, N2 = 59, U = 2,111, z = 2.77, P = 0.006, Cohen's d = 0.54). Other participants (n = 85) did not (abstraction cost $0.27; Mann–Whitney U N1 = 44, N2 = 41, U = 805, z = 0.85, P = 0.395, Cohen's d = 0.19). Perceptual distinction begets behavioral distinction in this task.

A comparison with previous dictator game experiments allows us to put the magnitude of the observed picture abstraction cost ($1.06) in context. Rachlin and Jones (26) asked participants to imagine the 100 people closest to them arranged in order of acquaintance, with 1 being socially the closest and 100 being the most distant. Allocations from a $10 endowment were approximately $1 lower for position 10 recipients than for position 1 recipients. Charness and Gneezy (28) found that allocations from a 25 Dutch guilder endowment ($13.74) were ~2.25 guilders ($1.24) lower for anonymous recipients than for recipients with surnames. The picture abstraction cost is on this scale.

Table 4. Summary results of the mind perception task in Experiment 5

Dimension	L1	L2
Realness	83	17
Agency	78	12
Experience	77	13

Columns show the levels of abstraction compared by participants. Rows show the three dimensions of comparison. Cells show the percentage of participants arriving at each judgement.

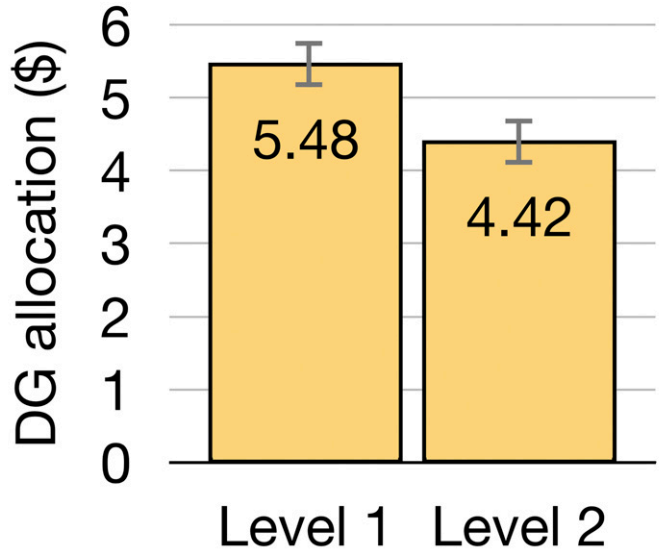

Fig. 4. Summary results of the dictator game (DG) task in Experiment 5. Bars show mean dollar allocations to L1 and L2 recipients. Error bars show SE.

General Discussion

We began by noting that pictures capture something of the mind that is important to us. Our core finding brings this notion into sharp relief. Both L1 and L2 pictures are perceived as depicting minds (albeit to a lesser degree than L0). Critically however, L1 pictures convey more mind than L2 pictures. We name this abstraction cost the Medusa effect after the mythical Gorgon whose image lacked the petrifying power of her gaze (Fig. 5).

All five experiments indicate that the visual medium bears some mental trace, more or less strongly, depending on the level of abstraction. This mental trace fits with established social cognitive effects that are induced by viewing pictures of faces [e.g., gaze cueing (7), prosociality (8)]. As well as establishing an intriguing cognitive phenomenon, the current findings suggest a novel hypothesis for future experiments—that the social cognitive effects of faces may be weaker at higher levels of pictorial abstraction as the depicted mind recedes.

Gray, Gray, and Wegner (9) emphasized the ethical import of dimensions of mind perception. For example, in their analysis, Agency was especially correlated with deserving punishment for wrongdoing, and Experience was especially correlated with the desire to avoid harming. These dimensions capture Aristotle's distinction between moral agents (whose actions can be morally right or wrong) and moral patients [who can have moral right or wrong done to them (29)]. Our dictator game findings contribute behavioral support for this framework by showing that the Medusa effect impacts the treatment of others. There is some precedent for picture factors affecting the treatment of depicted people. For example, compassion fade refers to the finding that a photograph showing several people in need elicits lower charitable donations than a photograph showing one person in need (30, 31). However, the basis of the Medusa effect is entirely different.

Fig. 5. The Medusa effect. The fictional Medusa (*Right* as L1) was reduced in potency when viewed as an image in a polished shield (*Left* as L2). Credit: National Gallery of Victoria, Melbourne. Gift of Professor Peter Tomory, 1991. This digital record has been made available on NGV Collection Online through the generous support of the Joe White Bequest (Public Domain; see *SI Appendix*).

We find that representational abstraction affects prosocial behavior, even when the number of depicted people is constant.

Although we focused here on L1 and L2, there is no *in principle* limit to the levels of visual abstractions that may be nested. Many artistic works contain multiple levels of abstraction (32). Droste effects and infinity mirrors hint at infinite regress (33, 34). How do people make sense of these structures? One possibility is that viewers remain mentally anchored in L0. From this vantage point, successive levels of abstraction recede into the mist, each level more faint than the last. Another possibility is that viewers mentally switch between levels as appropriate to the task at hand. On this account, whichever level is adopted substitutes for L0 temporarily, and pictures within it substitute for L1 temporarily. Only two levels of representation need to be managed at any moment. These two possibilities generate diverging predictions. For example, the anchored account implies that abstraction costs can only go in one direction: minds at a higher level of abstraction should always seem less potent than minds at a lower level of abstraction. The switch account permits abstraction costs in either direction: for a viewer inhabiting L1 (as when engrossed in a movie), minds in L0 may be temporarily deprecated. Our finding that an orientation to L2 frequently occurred in the first fixation would seem to favor the switch account, with L1 temporarily occupying the ground level of perception. Comparing numeric ratings for L0 versus L1 and L1 versus L2 could provide a more direct test of alternatives. The switch account predicts that the latter L1 rating will converge on L0.

As well as their theoretical interest, our findings have implications for understanding pictures in the many applied settings in which they arise. The past decade has seen a major shift from face-to-face interaction to online interaction. In our parlance, this shift increases the level of abstraction at which the interaction occurs, from L0 to L1. In so doing, it also increases the level of abstraction for any pictures present in the interaction, from L1 to L2. The implication is that mind perception is attenuated throughout the whole stack. This is no mere intellectual curiosity. L2 images now pervade legal, educational, and healthcare settings in which regard for minds is paramount (35). To give a concrete example, some psychological assessments involve reading social information from faces (36). These faces are L1 pictures when the test is administered in person but L2 pictures when the test is administered online. In this context, the viewer's response, and hence the diagnostic outcome, could depend on the level of abstraction. Or consider jurors weighing photographic evidence in a virtual trial, teachers presenting visual materials online, and cyber bullies sharing pictures of their victims. In all of these settings, outcomes hinge on the sensitivity to the minds of others—precisely what is lost with an additional layer of abstraction.

Such examples raise empirical questions about the nature and scope of picture abstraction costs. One approach to addressing these questions would be to identify conditions in which the Medusa effect can be overturned, perhaps by manipulating a picture's content (e.g., L1 robot versus L2 human) or format (e.g., static L1 versus moving L2). Another promising approach would be to examine individual differences between observers. Our dictator game data suggest that some people may be less susceptible than others to the Medusa effect. The range of susceptibility may reflect individual differences in underlying cognitive abilities. For example, children younger than 2 y can fail to distinguish between images and real objects (37). Among adults, there are large individual differences in face perception ability (38, 39). More generally, it is not clear whether abstraction costs are specific to mind perception from faces or whether they also apply to other judgements and other domains or modalities (e.g., objects, language, and music). Future experiments could test whether nonface objects such as houses look less real, or less valuable, in L2 than in L1. For now, we show that faces in the same image evoke mind perception to different degrees, depending on their level of abstraction. All pictures are equal, but some are more equal than others.

Methods

Research Ethics. All studies were approved by the University of British Columbia's Behavioral Research Ethics Board (Experiments 1 to 3 and 5; Approval No. H10-00527) or the Ethics Committee of the Department of Psychology, University of York (Experiment 4; Approval No. 834). All participants gave informed consent.

Experiment 1.

Participants. A total of 320 participants (41% female, 59% male; age range 19 to 80 y old) in the United States completed the study online from Amazon Mechanical Turk in exchange for monetary compensation. Participants were screened by Internet Protocol (IP) address to preclude repeat submissions.

Stimuli and design. The initial stimulus set comprised 30 photographs downloaded from the internet. Each photo depicted an L1 person and an L2 person in a single scene. For example, a person (L1) holding a portrait photograph (L2) or a computer user (L1) and onscreen interlocutor (L2). These scenes were visually diverse, ensuring that L1 and L2 each varied in terms of size, quality, and onscreen location (left or right). The depicted L1 and L2 persons also varied in age, gender, race, and emotional expression. One scene depicting an infant was rejected during piloting. The remaining 29 scenes were cropped to a standard size of 400 pixels high × 600 pixels wide and viewed on the participant's own device. Stimulus presentation and response capture were controlled using Qualtrics. Participants were randomly assigned to the Experience condition ($n = 106$), the Agency condition ($n = 106$), or the Realness condition ($n = 108$). For each scene, the participant's task was to indicate which of the two people seemed higher in the given attribute (Fig. 2*A*). This 2AFC method originated in psychophysical research (40) in which it was developed as a sensitive measure of perceptual discrimination (41).

Procedure. Participants accessed the study online from Amazon Mechanical Turk. Task instructions for each condition are shown in *SI Appendix*. Each trial consisted of a single scene which was presented onscreen for 2 s. All participants completed all trials in a different random order, pressing the "z" key or the "m" key to indicate the selection of the person on the left or the person on the right. The experiment was self-paced and took ∼5 min to complete.

Experiment 2.

Participants. A total of 320 participants (32% female, 68% male) in the United States completed the study online from Amazon Mechanical Turk in exchange for monetary compensation. Participants were screened by IP address to preclude repeat submissions and to prohibit participants who had completed Experiment 1.

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Stimuli and design. The same stimuli as Experiment 1 were used. Participants were randomly assigned to the Experience condition (n = 109), the Agency condition (n = 104), or the Realness condition (n = 107).

Procedure. Participants accessed the study online from Amazon Mechanical Turk. Their task was to rate each of the two people shown in an image based on Experience, Agency, or Realness. Task instructions for each condition are presented in *SI Appendix*. Each trial consisted of a single image presented onscreen along with the attribute questions (e.g., Experience) presented immediately above and below the image. The top question referred to the person on the left side of the image, and the bottom referred to the person on the right side. Participants answered each question by moving a slider to a whole number along a scale ranging from 0 to 10. The trial order was randomized. The experiment was self-paced and took ∼5 min to complete.

Experiment 3.

Participants. A total of 36 undergraduate students (79% female, 21% male, age range 18 to 29 y old) from the University of British Columbia completed the study in exchange for course credit.

Stimuli and design. The same stimuli as Experiments 1 and 2 were used. Each participant was seated ∼57 cm from the 22-in computer screen at a resolution of 1,680 × 1,050 pixels. Participants were instructed to keep their head steady during the experiment to ensure their eye movements would be accurately monitored by a SensoMotoric Instruments (SMI) Red desktop eye-tracking system with a sampling rate of 120 Hz, accuracy of 0.4°, and spatial resolution of 0.03°.

Procedure. Participants completed a nine-point SMI eye fixation calibration. They were then instructed to view the presented images as they normally would. Images were displayed onscreen for 5 s with a 2-s central fixation cross presented between trials. The experiment progressed automatically. Images appeared in a random order. The experiment took ∼4 min to complete.

Experiment 4.

Participants. A total of 200 undergraduates from the University of York (age range 18 to 25 y old) participated in exchange for a sweet reward. The first 100 participants were allocated to Transition 1, and the second 100 participants were allocated to Transition 2.

Stimuli and design. Two final-year undergraduates (Person A and Person B), who were unfamiliar to our first-year participants, volunteered as experimental models. In advance of testing, each model was photographed from a distance of ∼1.5 m using an iPhone 11 camera on portrait settings. Each photo captured the whole of the model's face with a neutral pose and no occlusions from a roughly frontal aspect. The photos were cropped to 2,400 pixels high × 1,800 pixels wide and color printed at life size onto A4 sheets, which were then laminated for use in the experiment.

This arrangement allowed us to counterbalance the two faces (Person A and Person B) across two modes of presentation so that each face appeared in each condition an equal number of times. In Transition 1, participants compared a live face (L0) against a life-size photograph (L1). A total of 50 participants saw Person A as L0 and Person B as L1. The remaining 50 saw Person B as L0 and Person A as L1.

The stimuli for Transition 2 were photographs of the Transition 1 setup. Immediately prior to testing for Transition 1, the live model was photographed from a distance of ∼1.5 m using the same camera as before. Each new photo captured the whole of the model's face together with the life-size photo she was holding. These new photos were cropped to 1,800 pixels high × 2,400 pixels wide and color printed onto A4 sheets, which were then laminated for use in the experiment.

Transition 2 participants thus compared an L1 picture against an L2 picture. A total of 50 new participants saw Person A as L1 and Person B as L2. Another 50 new participants saw Person B as L1 and Person A as L2. Fig. 2*B* summarizes the situation for Transition 1 and Transition 2.

For both groups, the participant's task was to answer the same three questions set out in Experiment 1: Which person seems more real? Which person seems to have more Agency (ability to do)? Which person seems to have more Experience (ability to feel)? In this experiment, all 200 participants answered all three questions.

Procedure. For both Transition 1 and Transition 2, the two counterbalanced versions of the experiment were run on consecutive days. On each day, the experiment was set up at a temporary exhibition stand at the main entrance of a university lecture theater 30 min before the beginning of class. For Transition 1, the live model (L0) remained seated behind a desk, holding the photographed face (L1) next to her own face. Passersby were invited to compare the two faces and to answer the three 2AFC questions, concerning Realness, Experience, and Agency, on a printed response sheet.

On each day, testing halted when 50 participants had responded. For Transition 2, the procedure was the same, except that no live model was present. Instead, participants compared the two faces presented on paper (L1 versus L2).

Experiment 5.

Participants. A total of 202 individuals (35% female, 65% male) from the United States participated via Amazon Mechanical Turk in exchange for a small payment. Participants were screened by IP address to preclude repeat submissions and to prohibit participants who had completed Experiment 1 or 2. Two participants were excluded following an attention check, resulting in a final sample of 200 participants. Participants were randomly assigned to the L1 dictator game (n = 100) or the L2 dictator game (n = 100).

Stimuli and design. Stimuli were the photographs used for Transition 2 in Experiment 4. These depicted Person A (L1) with a life-size photo of Person B (L2) or Person B (L1) with a life-size photo of Person A (L2). To decorrelate the level of pictorial abstraction (L1, L2) and spatial location (left, right), we used both the original displays and their mirror images (i.e., horizontally inverted; lettering removed to eliminate inversion cues). This addition resulted in four versions of the experiment (one for each display) such that facial identity, picture abstraction, and laterality were fully counterbalanced. In each version, participants completed the mind perception task used in Experiment 4, deciding which of two people (Person A or Person B) seemed higher in Realness, Agency, and Experience. Participants then proceeded to a one-shot dictator game using the same display. In the dictator game, the participants' task was to share a $10 endowment by allocating whatever dollar amount they chose ($0 to 10) to a specified onscreen recipient. In each version, participants were randomly assigned the L1 person (total n = 100) or the L2 person (total n = 100) as the recipient, indicated by an onscreen arrow and text instructions. Our main interest was whether participants in the L1 condition made higher dollar allocations than participants in the L2 condition.

Procedure. The mind perception task always preceded the dictator game task. Instructions for both tasks are reproduced in *SI Appendix*. The assigned stimulus display, depicting Person A and Person B, remained onscreen throughout the mind perception task. Three pairs of radio buttons, providing left/right person options for Realness, Agency, and Experience, were presented immediately below the display. For each of the three dimensions, participants chose the person on the left or the person on the right. In the dictator game that followed, the same stimulus display was presented again, this time with an arrow pointing to either the L1 person or the L2 person, specifying the recipient. A slider showing dollar units ($0 to 10) was presented immediately below the display. Participants selected their allocation to the recipient by dragging the slider. After committing the allocation, participants completed a final attention check by selecting option four from a list of five options one through five. Two participants who failed this attention check were excluded. The entire experiment took ∼5 min to complete.

Data Availability. All data have been deposited in a publicly acessible database, the Open Science Framework, and can be accessed via the following link: https://osf.io/fjp54/ (42).

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